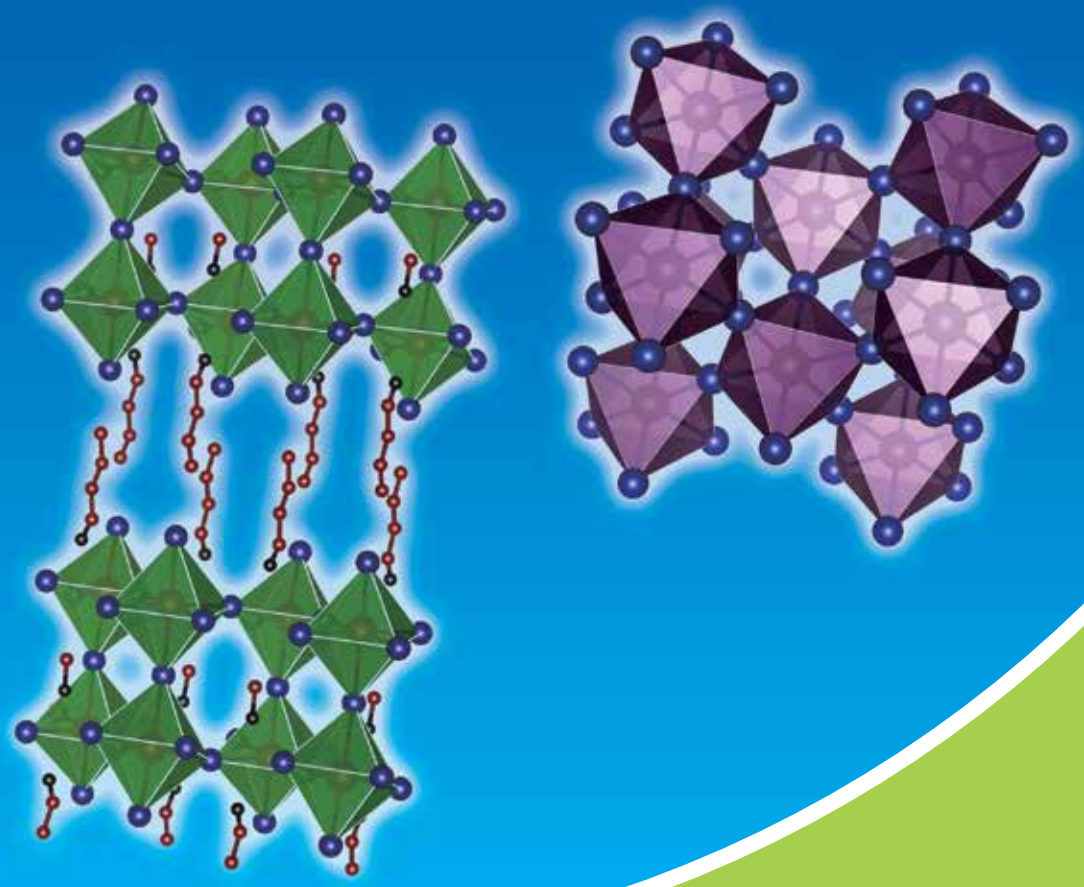
MATERIALS

有機無機ペロブスカイト前駆体

Organic-Inorganic Perovskite Precursors



有機オニウム塩

ハロゲン化鉛

その他の鉛化合物

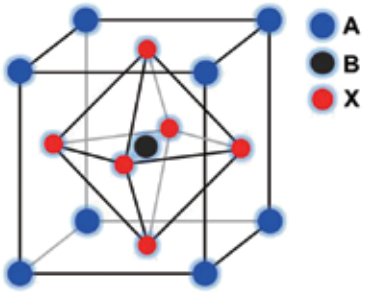
ハロゲン化セシウム

ハロゲン化ビスマス

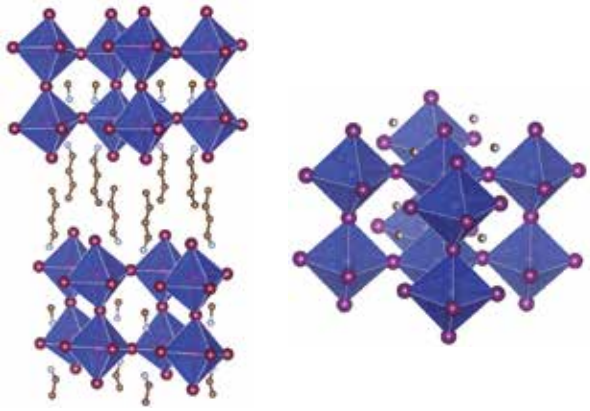
ハロゲン化スズ

有機無機ペロブスカイト前駆体

ペロブスカイトはチタン酸カルシウム（$CaTiO_3$）の鉱物名で、ABX_3（Aは2価、Bは4価の金属イオン）で表される化合物をペロブスカイト型化合物と総称しています。正方晶や斜方晶のペロブスカイトは強誘電性を示し、チタン酸バリウム（$BaTiO_3$）が強誘電体や圧電体としてよく知られています[1]。また、銅酸化物を基本単位とする酸化物高温超伝導体は、すべてペロブスカイト構造を持っています[2]。これらのペロブスカイト型化合物は金属イオンと酸素のみで構成されており、焼結法などの物理的な手法で作成されます[3]。焼結の際、金属イオンの種類や比率を変えたり、添加物を加えたりすることで物性が劇的に変化するのがペロブスカイト型化合物の特徴です。また、酸化物だけでなく、金属ハロゲン化物などを成分とするペロブスカイト型化合物も知られています。



ペロブスカイト型化合物におけるAサイトの陽イオン成分を、有機アンモニウム等に替えることも可能です。この場合、化学的な手法を用いてペロブスカイト化合物を合成できます。このペロブスカイト型化合物には有機成分が含まれていることから、有機無機ペロブスカイト化合物と呼ばれており、金属イオンは主に錫や鉛が用いられます[4,5]。一般式で$[(RNH_3)_mMX_n]$などで表され、金属イオンMやハロゲンX、有機基Rを変えることで、その構造や物性を緻密に制御できます。錫の有機無機ペロブスカイト化合物は電気伝導性に優れ[6]、鉛のそれは光物性などに優れています[7]。また、ハロゲンを変えるだけでバンドギャップの制御が可能で[8]、原料であるハロゲン化有機オニウム塩とハロゲン化金属化合物に含まれるハロゲンの種類および混合比により、ハロゲンの含有比を変えることが可能です。有機基Rは、メチル基や長鎖アルキル基、フェニル基、ベンジル基、フェネチル基などであり、有機物の骨格の多様性が構造の制御に活かされています。例えば、R＝メチルの場合は$[(MeNH_3)MX_3]$の化学組成を持つ3次元の立方晶ペロブスカイト構造を形成します[9]。R = C_nH_{2n+1} (n = 2以上)の場合は、2次元ペロブスカイト層を形成し、アルキル鎖の長さに応じて層間の距離が変化します[10]。



有機無機ペロブスカイト型化合物の応用例として、ペロブスカイト太陽電池が挙げられます[11-15]。この太陽電池には、3次元立方晶を有する$[(MeNH_3)MX_3]$が主に用いられています。また、この太陽電池におけるペロブスカイト構造には、Aサイトへのホルムアミジニウム[16]やセシウム[17]の導入についても検討されています。近年盛んに研究されているペロブスカイト太陽電池は、他の有機系太陽電池（有機太陽電池（OPV）、色素増感太陽電池（DSSC））のエネルギー変換効率を凌いでおり、溶液塗布による安価な製造プロセスにおいてもデバイスを作成可能です。

文　献

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2) Y. Tokura, H. Takagi, S. Uchida, *Nature* **1989**, *337*, 345.
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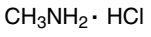
有機オニウム塩

塩化物塩

M0138 25g 500g



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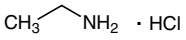
E0205 25g 500g



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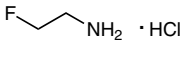

2-Fluoroethylamine Hydrochloride
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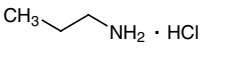
P0522 25g



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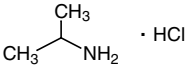

Isopropylamine Hydrochloride
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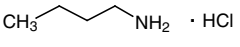
B0710 25g 500g



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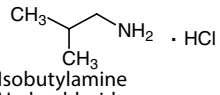

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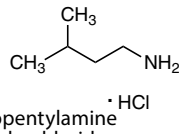

Isopentylamine Hydrochloride
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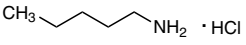

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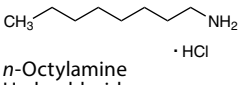

n-Octylamine Hydrochloride
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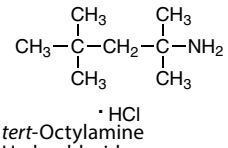

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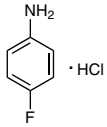
F1271 5g 25g



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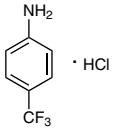
T3833 1g 5g



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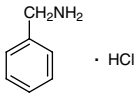
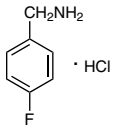
CAS RN: 90774-69-9

B0407 25g 100g 500g



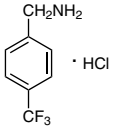
Benzylamine Hydrochloride
CAS RN: 3287-99-8

F1255 1g 5g



4-Fluorobenzylamine Hydrochloride
CAS RN: 659-41-6

T3836 1g 5g



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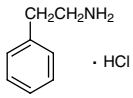

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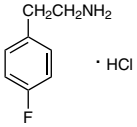

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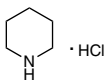
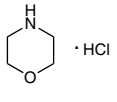


Piperidine Hydrochloride
(Low water content)
CAS RN: 6091-44-7

M3284 5g 25g



Morpholine Hydrochloride
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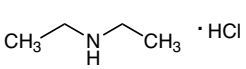
D0468 25g 500g



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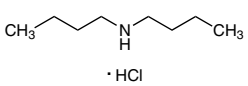

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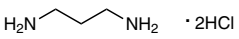
D5253 1g 5g



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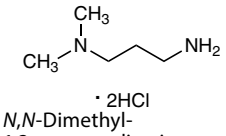
D5617 1g 5g



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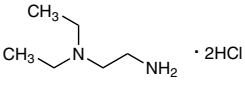

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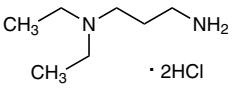

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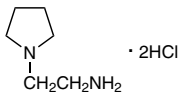
A3393 5g



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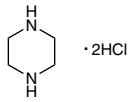
CAS RN: 65592-36-1

P2491 1g 5g



Piperazine Dihydrochloride
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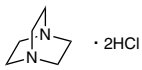
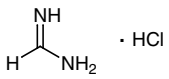
D5251 1g 5g



1,4-Diazabicyclo[2.2.2]-octane Dihydrochloride
CAS RN: 49563-87-3

F0103 5g 25g



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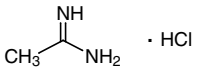
A0008 25g 500g



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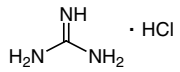
CAS RN: 124-42-5

G0162 25g 500g



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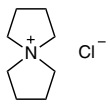
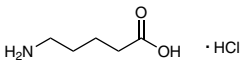


5-Azoniaspiro[4.4]nonane Chloride
CAS RN: 98997-63-8

A0436 1g 5g



5-Aminovaleric Acid Hydrochloride
(Low water content)
CAS RN: 627-95-2

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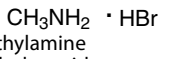
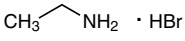
M2589 1g 5g 25g



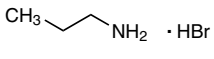
Methylamine Hydrobromide
(Low water content)
CAS RN: 6876-37-5

E0056 25g 500g



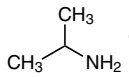
Ethylamine Hydrobromide
CAS RN: 593-55-5

P2502 1g 5g



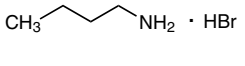
Propylamine Hydrobromide
CAS RN: 4905-83-3

I1041 1g 5g



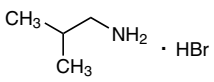
Isopropylamine Hydrobromide
CAS RN: 29552-58-7

B5186 1g 5g



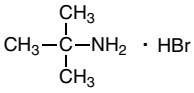
Butylamine Hydrobromide
CAS RN: 15567-09-6

I1007 1g 5g



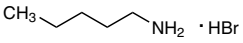
Isobutylamine Hydrobromide
CAS RN: 74098-36-5

B5187 1g 5g



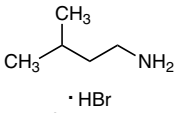
tert-Butylamine Hydrobromide
CAS RN: 60469-70-7

P2739 1g 5g



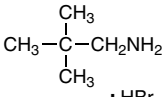
Pentylamine Hydrobromide
CAS RN: 7334-94-3

I1094 1g 5g



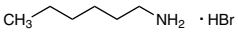
Isopentylamine Hydrobromide
CAS RN: 2733412-57-0

N1156 1g 5g



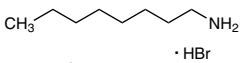
Neopentylamine Hydrobromide
CAS RN: 2710685-35-9

H1678 1g 5g



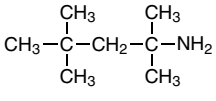
Hexylamine Hydrobromide
CAS RN: 7334-95-4

O0442 1g 5g



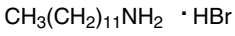
n-Octylamine Hydrobromide
CAS RN: 14846-47-0

T3783 1g 5g



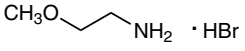
tert-Octylamine Hydrobromide
CAS RN: 1093859-61-0

D5537 1g 5g



Dodecylamine Hydrobromide
CAS RN: 26204-55-7

M3287 1g 5g

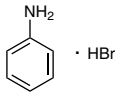


2-Methoxyethylamine Hydrobromide
CAS RN: 663941-77-3

C3531 1g 5g

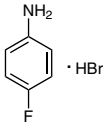
Cyclohexanemethylamine Hydrobromide

A2985 1g 5g



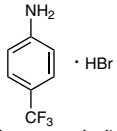
Aniline Hydrobromide
CAS RN: 542-11-0

F1272 5g 25g



4-Fluoroaniline Hydrobromide
CAS RN: 85734-18-5

T3834 1g 5g

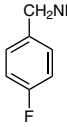


4-(Trifluoromethyl)aniline Hydrobromide
CAS RN: 148819-81-2

B5185 1g 5g

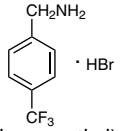
Benzylamine Hydrobromide
CAS RN: 37488-40-7

F1227 1g 5g



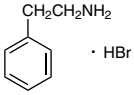
4-Fluorobenzylamine Hydrobromide
CAS RN: 2270172-94-4

T3837 1g 5g



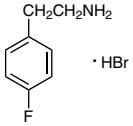
4-(Trifluoromethyl)-benzylamine Hydrobromide

P2388 1g 5g



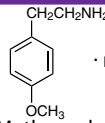
2-Phenylethylamine Hydrobromide
CAS RN: 53916-94-2

F1229 1g 5g



4-Fluorophenethylamine Hydrobromide
CAS RN: 1807536-06-6

M3239 1g 5g

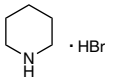


2-(4-Methoxyphenyl)-ethylamine Hydrobromide
CAS RN: 2705331-53-7

P2484 1g 5g

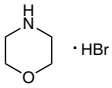
Pyrrolidine Hydrobromide
CAS RN: 55810-80-5

P2487 1g 5g



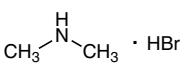
Piperidine Hydrobromide
CAS RN: 14066-85-4

M3285 5g 25g



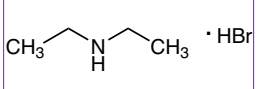
Morpholine Hydrobromide
CAS RN: 6377-82-8

D5092 1g 5g



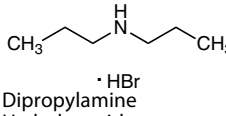
Dimethylamine Hydrobromide
CAS RN: 6912-12-5

D4667 1g 5g



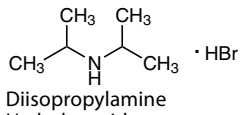
Diethylamine Hydrobromide
CAS RN: 6274-12-0

D5853 5g



Dipropylamine Hydrobromide
CAS RN: 7334-96-5

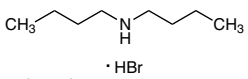
D5768 5g



Diisopropylamine Hydrobromide
CAS RN: 30321-74-5

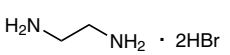
価格についてはウェブサイトでご覧いただけます。ウェブサイトでは構造式から試薬を検索することができます。
www.TCIchemicals.com/JP/ja/structure-search

D5857 5g



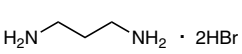
Dibutylamine Hydrobromide
CAS RN: 10435-44-6

E1221 1g 5g



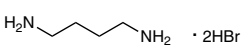
Ethylenediamine Dihydrobromide
CAS RN: 624-59-9

D5090 1g 5g



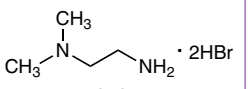
1,3-Diaminopropane Dihydrobromide
CAS RN: 18773-03-0

D5685 1g 5g



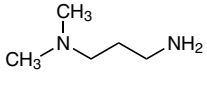
1,4-Diaminobutane Dihydrobromide
CAS RN: 18773-04-1

D5615 1g 5g



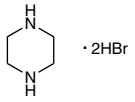
N,N-Dimethyl-ethylenediamine Dihydrobromide
CAS RN: 1245570-04-0

D5618 1g 5g



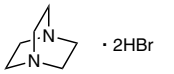
3-(Dimethylamino)-propylamine Dihydrobromide
CAS RN: 2710685-13-3

P2490 1g 5g



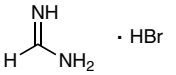
Piperazine Dihydrobromide
CAS RN: 59813-05-7

D5250 1g 5g



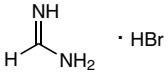
1,4-Diaza-bicyclo[2.2.2]octane Dihydrobromide
CAS RN: 54581-69-0

F0973 1g 5g 25g



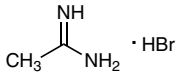
Formamidine Hydrobromide
(Low water content)
CAS RN: 146958-06-7

F1244 1g 5g 25g



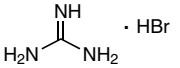
Formamidine Hydrobromide
(99.99%, trace metals basis)
CAS RN: 146958-06-7

A3292 1g 5g



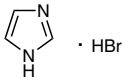
Acetamidine Hydrobromide
CAS RN: 1040352-82-6

G0449 1g 5g



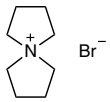
Guanidine Hydrobromide
CAS RN: 19244-98-5

I1006 1g 5g



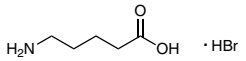
Imidazole Hydrobromide
(Low water content)
CAS RN: 101023-55-6

A3091 1g 5g



5-Azoniaspiro[4.4]nonane Bromide
CAS RN: 16450-38-7

A3094 1g 5g



5-Aminovaleric Acid Hydrobromide
(Low water content)
CAS RN: 2173111-73-2

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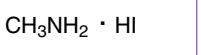
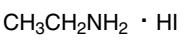
M2556 1g 5g 25g 100g



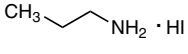
Methylamine Hydroiodide
(Low water content)
CAS RN: 14965-49-2

E1045 1g 5g



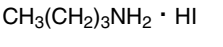
Ethylamine Hydroiodide
CAS RN: 506-58-1

P2212 1g 5g



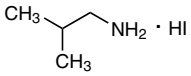
Propylamine Hydroiodide
CAS RN: 14488-45-0

B4433 1g 5g



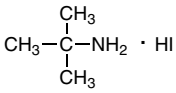
Butylamine Hydroiodide
CAS RN: 36945-08-1

I0935 1g 5g



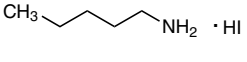
Isobutylamine Hydroiodide
CAS RN: 205508-75-4

B4434 1g 5g



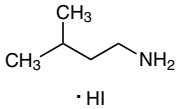
tert-Butylamine Hydroiodide
CAS RN: 39557-45-4

P2740 1g 5g



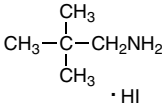
Pentylamine Hydroiodide
CAS RN: 60762-85-8

I1095 1g 5g



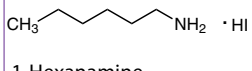
Isopentylamine Hydroiodide
CAS RN: 2733412-76-3

N1157 1g 5g



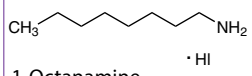
Neopentylamine Hydroiodide
CAS RN: 2733412-38-7

H1679 5g



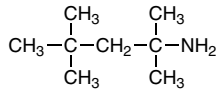
1-Hexanamine Hydroiodide
CAS RN: 54285-91-5

O0485 1g 5g



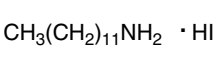
1-Octanamine Hydroiodide
CAS RN: 60734-63-6

T3785 1g 5g



tert-Octylamine Hydroiodide
CAS RN: 2733942-06-6

D5538 1g 5g

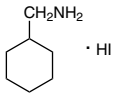


Dodecylamine Hydroiodide
CAS RN: 34099-97-3

C3532 1g 5g

Cyclohexylamine Hydroiodide
CAS RN: 45492-87-3

C3425 1g 5g

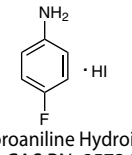


Cyclohexanemethylamine Hydroiodide
CAS RN: 2153504-15-3

A2778 1g 5g

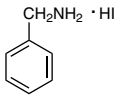
Aniline Hydroiodide
CAS RN: 45497-73-2

F1273 1g 5g



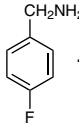
4-Fluoroaniline Hydroiodide
CAS RN: 85734-19-6

B4566 1g 5g



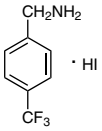
Benzylamine Hydroiodide
(Low water content)
CAS RN: 45579-91-7

F1228 1g 5g



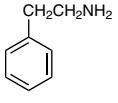
4-Fluorobenzylamine Hydroiodide
CAS RN: 2097121-30-5

T3838 1g 5g



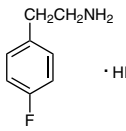
4-(Trifluoromethyl)-benzylamine Hydroiodide
CAS RN: 2710811-32-6

P2213 1g 5g



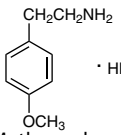
2-Phenylethylamine Hydroiodide
CAS RN: 151059-43-7

F1203 1g 5g



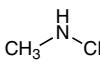
2-(4-Fluorophenyl)-ethylamine Hydroiodide
CAS RN: 1413269-55-2

M3240 1g 5g



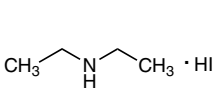
2-(4-Methoxyphenyl)-ethylamine Hydroiodide
CAS RN: 2588234-99-3

D4555 1g 5g



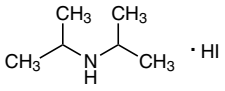
Dimethylamine Hydroiodide
CAS RN: 51066-74-1

D4643 1g 5g



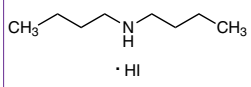
Diethylamine Hydroiodide
CAS RN: 19833-78-4

D5769 5g



Diisopropylamine Hydroiodide
CAS RN: 132396-99-7

D5858 5g

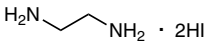


Dibutylamine Hydroiodide
CAS RN: 79886-80-9

M3286 5g 25g

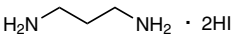
Morpholine Hydroiodide
CAS RN: 58464-45-2

E1222 1g 5g



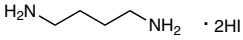
Ethylenediamine Dihydroiodide
CAS RN: 5700-49-2

D5091 1g 5g



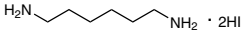
1,3-Diaminopropane Dihydroiodide
CAS RN: 120675-53-8

D5686 1g 5g



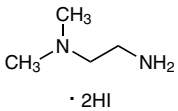
1,4-Diaminobutane Dihydroiodide
CAS RN: 916849-52-0

D6035 1g 5g



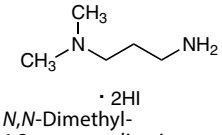
1,6-Hexanediamine Dihydroiodide
CAS RN: 20208-23-5

D5616 1g 5g



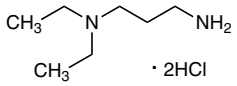
N,*N*-Dimethylethylenediamine Dihydroiodide
CAS RN: 244234-52-4

D5619 1g 5g



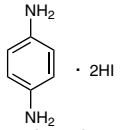
N,*N*-Dimethyl-1,3-propanediamine Dihydroiodide
CAS RN: 2561497-43-4

D5861 5g



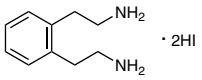
3-(Dimethylamino)-propylamine Dihydroiodide
CAS RN: 99310-71-1

P2389 1g



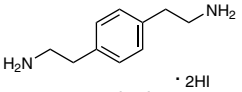
1,4-Phenylenediamine Dihydriodide
CAS RN: 116469-02-4

B6569 1g 5g



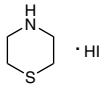
2,2′-(1,2-Phenylene)-bis(ethan-1-amine) Dihydroiodide

B6570 1g 5g



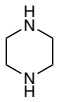
1,4-Benzenediethanamine Dihydroiodide
CAS RN: 2739684-32-1

T4375 1g 5g



Thiomorpholine Hydroiodide
CAS RN: 118725-79-4

P2492 1g 5g

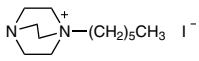


Piperazine Dihydriodide
CAS RN: 58464-47-4

D5252 1g 5g

1,4-Diazabicyclo[2.2.2]-octane Dihydriodide
CAS RN: 33322-06-4

H1759 5g

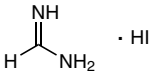


1-Hexyl-1,4-diaza-bicyclo[2.2.2]octan-1-ium Iodide
CAS RN: 1009321-13-4

F0974 1g 5g 25g 100g

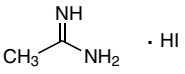
Formamidine Hydroiodide
(Low water content)
CAS RN: 879643-71-7

F1263 1g 5g 25g



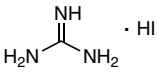
Formamidine Hydroiodide
(99.99%, trace metals basis)
CAS RN: 879643-71-7

A2902 1g 5g



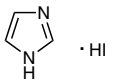
Acetamidine Hydroiodide
(Low water content)
CAS RN: 1452099-14-7

G0450 1g 5g



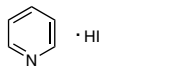
Guanidine Hydroiodide
CAS RN: 19227-70-4

I0970 1g 5g



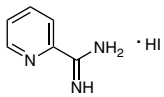
Imidazole Hydroiodide
(Low water content)
CAS RN: 68007-08-9

P2672 5g



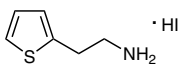
Pyridine Hydroiodide
CAS RN: 18820-83-2

A3754 1g 5g



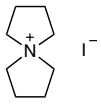
Picolinimidamide Hydroiodide

A3720 1g 5g



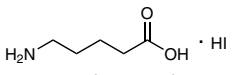
2-(Thiophen-2-yl)ethan-1-amine Hydroiodide
CAS RN: 2414055-94-8

A3093 1g 5g



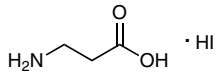
5-Azoniaspiro[4.4]nonane Iodide
CAS RN: 45650-35-9

A2984 1g 5g



5-Aminovaleric Acid Hydroiodide
(Low water content)
CAS RN: 1705581-28-7

A3112 1g 5g



β-Alanine Hydroiodide
(Low water content)
CAS RN: 2096495-59-7

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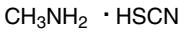
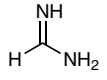
M2991 1g 5g



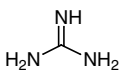
Methylamine Thiocyanate
CAS RN: 61540-63-4

F1153 1g 5g



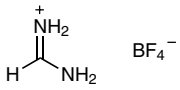
Formamidine Thiocyanate
CAS RN: 1821033-48-0

G0230 25g 500g



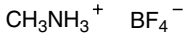
Guanidine Thiocyanate
CAS RN: 593-84-0

F1152 1g 5g



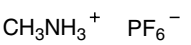
Formamidinium Tetrafluoroborate
CAS RN: 2607106-18-1

M2990 1g 5g



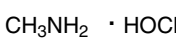
Methylamine Tetrafluoroborate
CAS RN: 42539-74-2

M2989 1g 5g



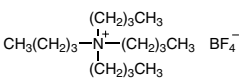
Methylammonium Hexafluorophosphate
CAS RN: 28302-50-3

M3134 1g 5g



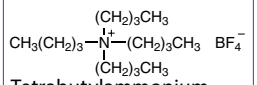
Methylamine Cyanate
CAS RN: 63405-91-4

T0914 25g 100g 500g



Tetrabutylammonium Tetrafluoroborate
CAS RN: 429-42-5

T2648 25g



Tetrabutylammonium Tetrafluoroborate
(Br <0.02 %)
CAS RN: 429-42-5

価格についてはウェブサイトでご覧いただけます。ウェブサイトでは構造式から試薬を検索することができます。
www.TCIchemicals.com/JP/ja/structure-search

ハロゲン化鉛

L0279 1g 5g 25g 100g 1kg
PbI_2
Lead(II) Iodide
(99.99%, trace metals basis)
[for Perovskite precursor]
CAS RN: 10101-63-0

L0288 1g 5g 25g 100g
$PbBr_2$
Lead(II) Bromide
[for Perovskite precursor]
CAS RN: 10031-22-8

L0346 1g 5g 25g 100g
$PbBr_2$
Lead(II) Bromide
(Low water content)
[for Perovskite precursor]
CAS RN: 10031-22-8

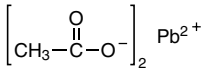
L0291 1g 5g
$PbCl_2$
Lead(II) Chloride
(purified by sublimation)
[for Perovskite precursor]
CAS RN: 7758-95-4

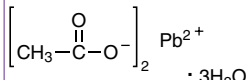
L0292 1g 5g 25g
$PbCl_2$
Lead(II) Chloride
[for Perovskite precursor]
CAS RN: 7758-95-4

C3569 1g 5g
$CsPbBr_3$
Cesium Lead Tribromide
(Low water content)
CAS RN: 15243-48-8

C3570 1g 5g
$CsPbI_3$
Cesium Lead Triiodide
(Low water content)
CAS RN: 18041-25-3

その他の鉛化合物

L0315 1g 5g 25g

Lead(II) Acetate
[for Perovskite precursor]
CAS RN: 301-04-2

L0330 25g 100g

Lead(II) Acetate Trihydrate
CAS RN: 6080-56-4

ハロゲン化セシウム

C2202 25g 100g
CsBr
Cesium Bromide
CAS RN: 7787-69-1

C2203 25g 100g
CsCl
Cesium Chloride
CAS RN: 7647-17-8

C2205 25g
CsI
Cesium Iodide
CAS RN: 7789-17-5

ハロゲン化ビスマス

B5787 5g 25g
BiI_3
Bismuth(III) Iodide
Anhydrous
CAS RN: 7787-64-6

B6339 5g 25g
$BiBr_3$
Bismuth(III) Bromide
CAS RN: 7787-58-8

B3546 25g 250g
$BiCl_3$
Bismuth(III) Chloride
CAS RN: 7787-60-2

ハロゲン化スズ

T3449 1g 5g
SnI_2
Tin(II) Iodide
[for Perovskite precursor]
CAS RN: 10294-70-9

T3570 1g 5g
$SnCl_2$
Tin(II) Chloride
[for Perovskite precursor]
CAS RN: 7772-99-8

T3573 1g 5g
$SnBr_2$
Tin(II) Bromide
[for Perovskite precursor]
CAS RN: 10031-24-0

東京化成工業株式会社

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